

Acknowledgements

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THE WISCONSIN COASTAL MANAGEMENT PROGRAM, part of Wisconsin Department of Administration, and overseen by the WISCONSIN COASTAL MANAGEMENT COUNCIL, was established in 1978 to preserve, protect and manage the resources of the Lake Michigan and Lake Superior coastline for this and future generations.

The Project Team

This project required coordination and completion of several steps including map documentation, photo preparation, photo interpretation, digital area/linear measurement and data sheet preparation. The following students worked as a team to help complete this project.

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Assessing Coastal Development Along Wisconsin's Great Lakes Shoreline: 1978 - 1992

Coastal Management Program Contract No. 840005-501.15

INTRODUCTION

The Wisconsin Coastal Management Program mission includes developing an understanding of change along the state's Great Lakes shoreline. Such change, of course, can be natural or human-based. This study was undertaken to document natural and human-based development within the coastal zone of the state's Lake Michigan and Lake Superior shorelines. The Wisconsin legislature has defined coastal zone as land within 1,000' (304.8 meters) of the shoreline (Ordinary High Water Mark - OHWM).

Future coastal zone planning and risk assessment requirements defined the types of data to be collected. Assessment of risk to structures built in the coastal zone requires a temporal analysis of structural development and shoreline modification(s). Planning of the coastal zone requires, as well, determination of the natural resource base. This study utilized U.S. Army Corps of Engineers historic color aerial photographs taken in 1978 and 1992.

This report documents both the original and amended contract to assess natural and developmental change within the coastal zone of Wisconsin's Great Lakes shorelines. Although the original contracted work was interrupted to include elements of the amended contract, no attempt will be made in this report to keep separate original vs. amended objectives, procedures or results. Goals of the amended contract include and expand those of the original.

PROJECT GOALS

Planning and assessment of hazards within the coastal zone defined the goals of this study. Within the Lake Michigan and Superior coastal zones, project goals included:

- Development of land use databases for 1978 and 1992
- Development of 1978 and 1992 databases of human modification of the shorelines
- Develop a database of built structures for 1992 Additional goals included:
 - Assess land use change within the coastal zone from 1978 to 1992
 - Assess human modification of the shoreline from 1978 to 1992

STUDY AREA

The project study area comprises the Wisconsin portion of the Lake Michigan and Lake Superior coastal zone (Figure 1). In 1982, the Wisconsin state legislature defined coastal zone as being that land within 1,000 feet (304.8 meters) of lake shoreline. Accordingly, the study area represents a 1,000' wide



Figure 1. Coastal Counties of Lake Michigan and Lake Superior

zone, the landward boundary of which is parallel to the coastline.

PROJECT METHODS

Aerial Photography

Using aerial photos to assess coastal development requires clear statement of goals, appropriate definition of coastal zone, meaningful classification scheme, appropriate historical and current aerial photos, appropriate interpretation procedure and method of documentation, and trained personnel.

Application of aerial photography to assess urban and natural resource features is documented well (Smith, 1968; Avery and Berlin, 1985; Lo and Noble, 1990; Ciciarelli, 1991; Boge et al., 1992; Hinckley and Walker, 1993). Specific applications to urban/human activities cover a wide range including urban nonpoint pollution assessment (Kim and Ventura, 1993), gully erosion analysis (Welch et al., 1985), historical analysis of urban development into coastal wetlands (Niedzwiedz and Batie, 1984), identifying structural additions to urban residential property (Niedzwiedz, 1990), and studying agricultural land use (Marsh et al., 1990).

Aerial photos have been used to map archeological sites, urban features, and to document changes to the landscape (Smith, 1968). MacConnell (1975) reports the use of black and white aerial photography (scale 1:20000) to map 20 years of land use change within the state of Massachusetts, including the coastal zone. As part of a larger Great Lakes study, the International Joint Commission (1993) used 1:24000 scale photos to map land use features along the Berrien County, Michigan segment of the Lake Michigan shoreline. Results of the photo analysis were used to assess residential riparian erosion/recession rates caused by fluctuating water levels.

Wisconsin's coastal zone includes diverse land use, from forests and wetlands, to land devoted to agricultural or urban uses. The uses of aerial photos long have been applied to study such land uses. Befort and Viliman (1985) studied aerial photos to classify forest habitat. McCarthy et al. (1982) evaluated spruce-fir forests to aid management. Wetlands analysis is possible with aerial photos of appropriate format, scale and seasonal timing. Scarpace et al. (1981) used digitized aerial photos to map wetlands, while Ferguson et al. (1993) and Barrett and Niering (1993) have monitored sawgrass habitat and marsh vegetation change using aerial photos.

Extensive use of aerial photography has been directed at coastal resources. Scherz and Van Domelsen (1973) used aerial photos to help assess water quality in Lake Superior near Duluth, Minnesota. Numerous studies have been made with aerial photos to aid management of coastal resources (Benton et al., 1978; Hill et al., 1985; Norton et al., 1985; Welch et al., 1992), to address change in coastal wetlands (Lyon and Greene, 1992), and to

examine urban development into coastal wetlands (Niedzwiedz and Batie, 1984).

Project Aerial Photos

In 1978, the U.S. Army Corps of Engineers (USACE) obtained panchromatic color aerial photos of the Wisconsin portion of the Lake Michigan coastline. In 1992, USACE obtained color aerial photo coverage of the Wisconsin portion of both Lake Superior and Lake Michigan coastlines. Both the 1978 and 1992 photos were flown at a scale of 1:6000 (1" = 500') and enlargements made at 1:2400 (1" = 200'). The 1978 photos were taken April 16th. The 1992 photos were flown May 13th.

Unlike most historical aerial photos covering the same area and flown at the same scale, the USACE photos of 1978 and 1992 were not flown with coincident photo centers or coverage. No individual flight lines were documented for the 1978 photos. Beginning at the Michigan border, the 1978 photos were taken incrementally to the Illinois border. Photos are documented with the photo date and photo number on the northern edge of each photo.

Flight lines were documented for the 1992 photos. Flight line #1 begins just south of the Wisconsin-Illinois border. The northern edge of each 1992 photo displays the photo date, flight line and photo number.

Both the 1978 and 1992 photo contact prints (1:6000) were flown to produce stereo coverage of the coastline. Adjacent photos overlap (endlap) about 60% with each other. The enlarged photos (1:2400) available for this study represent every other photo contact print, therefore, only photographic, not stereo coverage, is provided by the enlarged photos. Approximately 1,800 photos (1:2400) cover Wisconsin's Lake Michigan shoreline, 900 for each flight year. About 1,200 photos covering the shoreline from Marinette to Sheboygan are on file at the Green Bay office of USACE. The Waukesha office of USACE has on file about 600 photos covering the shoreline from Sheboygan to the Illinois border.

Photo Preparation

Photos used in this study are owned by USACE. As a result, all photo documentation and interpretive work was applied to acetate affixed to each photo. Preparing photos for interpretation included the following:

- 1. Affix label and document photo number/flight line, photo date and Public Land Survey System (PLSS) information.
- 2. Mark photo fiducials (orange ink). Fiducials allow the registration of acetate overlays to the photos, if required.
- 3. Mark control points (orange ink). Typically these points are road intersections and, or buildings, stable objects

that could be referenced against controlled maps for future mapping applications.

- 4. Locate and mark interpretation boundary lines (black ink). These lines are used to denote a common boundary between adjacent photos. Land use interpretive lines end at these boundary lines, which eliminates redundant interpretive work.
- 5. Locate, mark and label PLSS section lines (red ink).
- 6. Locate, mark and label civil boundary lines (green ink).
- 7. Locate and mark 1,000' coastal zone boundary line (blue ink). A divider was used to scribe a line 1000' away and parallel to the line defined by land meeting water. In cases where large streams entered Lake Michigan, a straight dashed line was drawn to represent a continuation of the shoreline.
- 8. Locate and mark top of bluff, and bottom of bluff if slumpage is evident (black ink). In practice, these lines were not drawn until the shoreline portion of the classification scheme was applied to the photos. Refer to the section Photointerpretive Process (page 11) for additional discussion.

Aerial Photo Interpretation (API)

The landscape within the coastal zone can represent a complex mix of natural to urban uses. The land use classification scheme developed for this study addresses the complexity of Wisconsin's coastal zone. The scheme is a modification of the scheme developed by International Joint Commission (1993) and includes the general use categories of residential, commercial, industrial, transportation, extractive, agricultural, natural, open land and other uses. Land uses have been measured by area (acres, hectares). Structures per land use have been located and marked for spatial reference. Structures are tallied by type for 1992.

Modification of the shoreline also has resulted. Sea walls, revetments, groins and permanent docks have been constructed. Sea walls and revetments are linear types. Their interpretation and measurement are presented in feet (meters). Groins and docks were counted.

CLASSIFICATION SCHEME

Residential Land

All residential areas include infrastructure to service the area. Boundary placement is made to separate residential areas by type. No attempt is made to distinguish roads/streets from the residential areas they serve. This convention is true for other classification types as well.

- 111 Multi-Family: Medium to High Rise. Large residential structure of five (5) or more stories. Access roads, parking areas, open space and recreational facilities associated with the structure(s) would be included in the type.
- Multi-Family: Low Rise. Large residential structures up to four (4) stories. Access roads, parking areas, open space and recreational facilities associated with the structure(s) would be included in the type.
- 113 Single Family, Duplex. Structures large and small used for residential use. The type includes lawn, landscaped areas, garage and driveways. Duplex structures are identified by twin driveways or a very wide driveway leading to an architecturally balanced structure.
- 115 Mobile Home Park. Residential area developed exclusively for mobile units.

Commercial and Industrial Land

Commercial land includes three (3) types: central business district; shopping center/mall; and, neighborhood business district. Each type includes all building structures, access roads/streets, parking facilities and other features commonly associated with each type.

- 121 Central Business District (CBD). Commercial land predominantly used for distribution or merchandizing of goods and services. Stores, hotels, office buildings, parking facilities and smaller warehouses constitute the components of this type. The CBD spatially is tight, vegetation is rare.
- Shopping Center/Mall. These commercial areas have developed away from the CBD. The type includes both "strip" type development and malls. Structures can range from large, flat roofed and rectangular (centers) to large, geometrically shaped. Both types include large parking areas adjacent to or completely surrounding the commercial structures.
- Neighborhood Business District (NBD). This type denotes small commercial areas within, or adjacent to residential areas. The type may be found in established or newer subdivision areas. NBD structures can range from conventional architecture to unusual geometric shapes. Small parking areas are associated with NBD commercial areas.

126 Institutional Land. The type reflects areas devoted to public or quasi-public uses. Examples include schools, churches, hospitals, prisons, etc., and their associated "grounds," green space, landscaping and parking facilities. When located within the CBD, public buildings without "grounds" often cannot be identified on aerial photos and would be classified as commercial (121).

Industrial Land

138 Industrial Park. The type includes both heavy and light industrial use areas.

Heavy industrial land contains facilities for the manufacture, storage and assembly of raw or partially processed products such as machinery, metals, chemicals, petroleum, or electrical power. Such industries often have large smokestacks and large storage areas. Warehouses and transportation facilities for bulk products and an open and interrupted street pattern characterize this type.

Light industrial land contains facilities for the manufacture or assembly of smaller, partially processed products such as electronics, appliances, and other secondary process products. Large smokestacks or raw material storage facilities are never present. Many modern light industries are well landscaped and are indistinguishable from commercial activity on aerial photographs.

Transportation Land

- 141 Air Transportation. Includes areas with airports and associated facilities, landing strips, hangers, parking areas and adjacent open areas.
- 142 Rail Transportation. This type includes railyards, terminal freight and storage facilities as well as stations for passengers. The type may include liquid storage facilities such as tank farms.
- 143 Water Transportation. This designation is applied to several water-based areas, including docks, warehouses and related land-based facilities for water transportation and commercial fishing. The type includes, as well, public marinas and their associated facilities: boat slips, buildings and parking areas.
- 143.1 Private Marina. Boat mooring areas adjacent to residential land are designated as private marinas. Often such areas include a protected slip(s), dredged waterway and, or a permanent docking structure built into the waterway.

- 143.2 Public Boat Landing. This type is applied to boat launching areas. Typically, facilities include only a ramp(s) from which boats may be launched and parking areas.
- 144 Divided Highway. This type includes transportation corridors with median strips between lanes. Typically, such roads are four or more lanes wide. Local streets are not included in this type.
- 145 Communications. Facilities and structures devoted to communications. These include radio/television towers, lighthouses and their grounds, buildings and parking areas.
- 146 Utilities. This type includes facilities for the production and distribution of energy. Such areas can include large buildings, towers, roads/parking facilities and, in the case of coal fired plants, large piles of raw coal.
- 147 Sewage Treatment Plant. Buildings, treatment lagoons, parking areas, access roads and grounds are included in this type.
- 148 Landfill. Landfill sites used to bury garbage define this type. Landfills cover an extensive area and are dominated by large excavated areas, mounds of exposed soil and access roads.

Extractive Land Use

- 171 Open Pit. The type represents open pit mining areas for extraction of sand, gravel, stone or rock. The type includes access roads and any structures.
- 172 Underground Mine. Mining of underground resources via shaft extraction. Surface features captured on aerial photos would be limited to small structures and access roads.
- 173 Well. Features associated with wells are limited. Identification of wells using only aerial photos is difficult.
- 179 Other Extractive Uses.

Agricultural and Natural Land

Abandoned Field (AF). These are agricultural units reverting to wild land. Woody vegetation and grass are abundant but tree crown cover is less than 30%. If tree crown cover were greater than 30%, the land would be classified as forest.

- 182 Agriculture Active (AG). Tilled or tillable crop land which is or recently has been intensively farmed. The boundaries on the ground usually are sharply defined and well maintained. The land supporting farm buildings is included as part of this type.
- 183 Forest (F). Areas of forest, deciduous, coniferous or mixed, having canopy closure of at least 30%. Areas with less than 30% canopy closure are classified as abandoned field.
- 184 Heath (H). Areas of heath plant community as well as grass, shrubs, and other low vegetation found on poor sandy soils.
- Open Water (W). Areas of open water found in lakes, rivers and large streams. Water depth is greater than three feet during the growing season. The boundary of coastal water is located by drawing a line at the river mouth to connect the edges of the coastline, or man-made features like roads, railroads or bridges crossing rivers or inlets are used to establish such a line.
- 186 Rock Ledge (RL). Rock outcrop areas at the coastline or within the coastal zone. Such outcrops are common in Door County.
- 187 Slump Zone (SL). Land located between upland bluff and beach. Slump zones begin at the bluff line and slope down to the beach.
- 188 Wetland (WT). This type covers the full spectrum of wetlands. These include seasonally flooded flats, shrub swamps, meadows, bogs, shallow and deep marshes, and forested wetlands. Each is described below.

<u>Seasonally flooded basins or flats</u> occur principally on stream floodplains. The most common plants are grasses and herbaceous species. The soil is waterlogged or covered with water during spring freshets, but well-drained during the growing season.

<u>Shrub swamps</u> often have waterlogged soil during the growing season, as much as six (6) inches of water may be present. Vegetation types include elder, buttonbush, dogwood and willow. Sedges usually are present in tussocks.

<u>Meadows</u> are vegetated with grasses, rushes and sedges. Soils are waterlogged through most of the growing season. Surface water is present only for a short period during the spring.

Bogs are unique wetland types that support a distinctive plant community, including most of the following: heath shrubs, cranberries, pitcher plants and sedges. Scattered black spruce, tamarack and red maple may be present. A mat of sphagnum moss is the most common feature of bogs.

<u>Shallow marsh</u> is wetter than meadow. The soil is completely waterlogged and often covered with up to six inches of water during the growing season. The predominant vegetation is emergent, including such plants as cattails, bulrushes, burreed, pickerelweed and arrowhead with some grasses and sedges present. The type is common to open water bodies.

<u>Deep marsh</u> has water depth ranging from six inches to three feet. Fairly large open water areas are bordered by, or interspersed with, emergent vegetation like that found in shallow marsh. Floating and submergent plants such as water lilies, duckweed, watershield and pondweeds also are present.

Forested Wetlands. This type represents areas of moist to saturated soil covered by forest canopy. The type is difficult to identify without stereo photography and, or with "leaves-on" photography.

Open and Other Land

- 191 Outdoor-Public Assembly
- 192 Urban Open Lots. Urban open is undeveloped land lying idle in the midst of urban areas or adjacent to them. This type includes land which has been cleared for urban development of an unknown use.
- 193 Outdoor Recreation. Outdoor recreation types are either mainly for participation, mainly for spectators, or are environmental in character. Each recreational type includes the recreational complex: access roads, parking facilities, buildings and other related facilities.

194 Cemeteries

Shoreline Modification

Development along the lakeshore often means modification at, or near, the shoreline. Land along the lakeshore is exposed to significant erosional forces. Recession of land mass is common. Agricultural and urban land uses destabilize shoreland, in effect accelerating erosion and land recession. To protect real estate and property, many property owners have constructed walls or revetments along their shoreline. Some owners also have built non-flow-through docks at the shoreline to provide mooring and protection for their boats. Groins, large rock structures perpendicular to the shoreline, have been built along Wisconsin's Lake Michigan shoreline.

195 Sea Walls (<u>V 195 V</u>). These structures are built parallel to the shoreline and typically are well defined, linear

features. Construction materials can include concrete, wood or interlocking sheet steel.

- 196 Revetments (<u>V 196 V</u>). Large rock or slab structures built parallel to the shoreline. Interpretively, revetments are less well defined, and appear wider than do sea walls.
- 197 Groins (* [red]). Groins are large rock structures built perpendicular to the shoreline into the water. Except for their distinct orientation and placement, groins appear similar to revetments.
- 198 Non-Flow-Through Dock (* [blue]). Such docks are permanent structures built into near-shore waters. Typically these docks are straight, their upper surface wide and well defined.

Structures - Industrial, Commercial and Residential

On the 1992 photos, buildings within the coastal zone are classified by type and location. Using a template of rectangles, for each building, a rectangle is selected that best represents the area of the building's "footprint." The selected rectangle then is positioned so that the leading edge of the building (relative to the shoreline) is located. Buildings for 1978 were counted by type. However, due to photo format differences, comparison of 1978 and 1992 structural counts may be inaccurate.

THE PHOTOINTERPRETIVE PROCESS

After photo preparation, each photo was interpreted using the classification scheme defined above. Area (land uses), linear (shoreline modification) and point (urban structures, groins, docks) types are represented in this study. Lines and, or symbols were used to define all types. Area types are represented by perimeter boundary lines and symbols to define and identify the areas. Line types representing modification to natural shoreline were defined using both lines and symbols. All area and line type symbols are recorded in black ink. Point types are defined by symbols and colored ink (see above).

Modifications to the shoreline, such as sea walls or revetments, are delineated by placing (painting) the 'V' symbol at the beginning and end of the modification. The type of modification is represented by placing the appropriate number between the 'V' symbols. For example, 195 positioned between two 'V' symbols means that a sea wall has been built along this section of shoreline. Shoreline classification was conducted before land use so that land use boundary lines placed along the shoreline would not 'hide' shoreline information.

Groins and non-flow-through docks were defined by point symbols (see above). In both cases, the symbol was placed at the point where the structure meets land. As discussed above, for

1992, buildings also were classified using point symbols. The delineation of buildings represents the last API procedure.

MEASUREMENT OF AREA, LINE AND POINT TYPES LOCATED WITHIN THE COASTAL ZONE

Area types (land use polygons) and line types (shoreline modification) measurements were made using the hardware/software facilities of the GIS Lab at the University of Wisconsin-Green Bay. Photo acetate overlays were affixed to large-format digitizers and each land use polygon digitized along the perimeter. Measurements recorded in square inches were converted to acres/hectares. Line measurements (in inches) of shoreline modifications were made using digitizers as well. Linear inch measurements were converted to linear feet/meters for each type of modification.

Point types (groins, structures) simply were tallied by count for each type. The area covered by each acetate was broken into civil jurisdiction and PLSS section designations.

Measurements (above) were separated by civil and PLSS designations as well, and documented permanently on each acetate overlay.

TALLY OF DATA

Measurements recorded on each photo acetate were transferred to data sheets. Three (3) levels of data sheets were used: PLSS Section Data; Civil Jurisdiction Summary Data; and County Summary Data (Appendix).

PLSS Section Data Sheet: One (1) PLSS Section Data sheet was used for each section located on a photo/acetate. Generally, 1-2 PLSS sections are located on a photo, however, up to four (4) sections per photo were recorded. Section level data sheets record photo documentation including photo year, photo number, county and community(ies) covered, and complete PLSS section location. Also recorded were number of residential, commercial, industrial and institutional structures (1992), area of land use by type, linear distance of sea walls and revetments, and the number of groins and non-flow-through docks.

Civil Jurisdiction Summary Data Sheet: This tally sheet summarizes the data for all PLSS section sheets found within each township, village or city. The sheet records photo year, county, name of civil jurisdiction, a complete listing of PLSS sections included in the summary, as well as all land use, shoreline and structure count data discussed above.

County Summary Data Sheet: The County Summary sheet summarizes all data for the towns, villages and cities located within the county. Documented information includes photo year, county name, an alphabetical listing of all civil jurisdictions within the county, and a summary of all land use, shoreline and

structure count data reported on Civil Jurisdiction Summary Data sheets.

LIMITATIONS AND SOURCES OF ERROR

The U.S. Army Corps of Engineers contracted for aerial photography of the Wisconsin portion of the Lake Michigan shoreline on April 21, 1978 and May 19, 1992. Both sets of photos are 1:6000 scale and panchromatic color, however, the 1978 photos are "leaves-off" while the 1992 photos are "leaves-on."

Copies of the original stereo photos (1:6000 scale) were not available for this study. Instead, enlargements (1:2400 scale) of the original photos were borrowed from Corps district offices in Green Bay and Waukesha. The enlargements provided photographic coverage only, not stereo coverage. Normally, for a project of this magnitude, photos would have been taken to meet the specific objectives of the study. The enlarged photos used for this project present limitations and introduce error beyond what would be reported with original photos flown specifically for this study. Limitations and errors associated with the photographs used are discussed below. Also presented below is discussion regarding methodological inconsistencies.

The following discussion of Limitations and Sources of Error is presented in an attempt to provide the reader a basic understanding of the issues. Any section of the discussion could apply to any of the results reported below. The Results sections of this report present findings without any comprehensive attempt to explain anomalies within, or between, the photo study years (1978 and 1992).

Photo Scale and Enlargements

All vertical aerial photographs not ratioed (enlarged or reduced to a common average scale) or rectified (common tilt/tip corrected to a horizontal reference plane) inherently are scale inaccurate. The original USACE photos (1978 and 1992) were not ratioed or rectified, therefore, their scale varies relative to topographic changes of the coastal zone, tip/tilt of the camera and changing elevation of the camera (aircraft). Enlargements of the original photos simply accentuate the inaccuracies found on the original photos.

Area and linear measurements taken off of the USACE enlarged photos reflect the inaccuracies inherent in those photos. Simple tests of shoreline distances for numerous PLSS sections within each county were conducted to establish linear accuracies of the photos. USGS topo sheets at 1:24000 scale were used to establish base shoreline distance measurements against which photo (1978 and 1992) shoreline distance measurements could be compared. No systematic errors were detected for the 1978 photos. However, only one (1) of 21 tests of the 1992 photos varied in the positive direction from USGS measurements. The remaining 20 tests varied in the negative direction and ranged from -0.8% to

-13.1%. The range of error, for 1978 was -5.3% to +9.6%, while the range of error for 1992 was -13.1% to +1.9% (see Table 1 page 17). Without a test of error for each photo used, there is no means to judge the direction or the amount of error relative to statistics associated with each photo. However, given the range of error found for the 1978 and 1992 photos, it is possible that 1,000 acres (405 ha) (actual) of coastal zone area could be reported as 1,096 acres (444 ha) in 1978 and 869 acres (352 ha) in 1992, a 227 acre (92 ha) difference.

"Leaves-On" Versus "Leaves-Off" Aerial Photography

There are distinct advantages and disadvantages of both "leaves-on" and "leaves-off" aerial photography. However, given the goals of this project, the 1978 "leaves-off" photography offers important advantages over the 1992 "leaves-on" photography. Vegetation in leaf can hide the details of built structures, including buildings and shoreline modifications. Roads can be hidden under tree crowns, as well as portions of lots landscaped and managed as residential land. Leaved canopies increase the effect of shadows. Shadows mask ground, understory and structural information leading to inaccurate interpretation. Land uses and/or structures hidden under the canopy of vegetation or masked by shadows can be underestimated in area, length or count. Land use types particularly affected (underestimated) are single family residential and wetland.

Stereo Versus Photographic Coverage

Both the 1978 and 1992 photo sets were taken to capture stereo (3-D) coverage of the Lake Michigan coastal area. This means that adjacent photos overlap approximately 60%. Stated another way, 60% of the shoreland area located on one photo also is located on an adjacent photo. The shoreland common to adjacent photos is "seen" from two different perspectives which allows stereo viewing (using a stereoscope).

The enlarged photos borrowed from USACE for this study represent photographic coverage only, or every other photo taken of shoreland. While photo (2-D) coverage at large scales can be used to interpret accurately many land use types (agricultural and most urban land), the lack of stereo viewing makes difficult the identification of wetland types and the exact location of bluff lines. Stereo viewing generally would have increased the interpretive accuracy of most land use, structural and shoreline features.

Incomplete Photo Coverage

For this study, the coastal zone is defined as a 1000' strip of land adjacent and parallel to the shoreline. Occasionally, photo coverage did not include all shoreland within 1000' of the water. As a result, total land area is underrepresented, the

exact land use types not covered are not known. In such cases, the area not captured on a particular photo was estimated by reference and comparison to coverage photos of the other flight year.

Missing Photo Coverage

Occasionally, photo coverage was missing from the USACE photo library. In such cases, as described above, coverage area missing was estimated by reference to photos of the other flight year. However, the exact land use types and shoreline features not represented on photos remain unknown.

Location of 1000' Coastal Zone Boundary

On each photo set, 1978 and 1992, a boundary line was drawn representing the 1000' coastal zone parallel to the shoreline. This line was located by scribing a landward line parallel to the line defined by the shoreline (where water meets land). The landward extent of the boundary line is a function of shoreline location, which in turn, is dependent on the water elevation of Lake Michigan. USACE (1978, 1992) reports that in April of 1978 Lake Michigan water elevation was about 578.4 feet (176.3 meters) and about 579.16 feet (176.5 meters) in May, 1992. The nine (9) inch difference in water elevation, while seemingly insignificant, could have shifted substantially landward the shoreline in extremely low slope beach or mud flat areas. The result of such a shift would be inclusion of inland areas NOT included in the 1978 coastal zone.

Lack of Beach Type in Classification Scheme

The width or extent of beach is dependent on slope of an area and water elevation. Since changes in the area of beach likely would reflect more the differences in 1978 and 1992 water levels (9 inches higher in 1992) than actual losses/gains due to erosion or development, no beach type was included in the study.

The lack of a beach type does affect measurement of area within the 1000' coastal zone. The landward extent of the coastal zone is 1000' from the <u>shoreline</u>. Any beach area lies between the shoreline and the base of the bluff, however area measurements of land use types were made only for those types lying between the base of the bluff and the interior boundary of the coastal zone. In most cases, beach strips represent only about five (5) acres per photo.

Positional Changes to the Shoreline: Natural vs. Urban Development

As discussed above, the landward extent of the 1000' coastal boundary is dependent on the location of the shoreline. Natural changes to shoreline position include both water elevation and

erosion/deposition of soil. Filling of coastal waters to accommodate urban development artificially changes shoreline In such cases, not only does the shoreline move "offshore," the interior coastal zone boundary line shifts toward the water. This "shift" in coastal boundaries skews area measurement. For example, in 1978 assume the coastal zone in an area to be all residential and that by 1992 100 acres of lake water is filled to develop commercial land. A "lakeward" shift in the location of the shoreline will occur due to the land filled for commercial use. However, this "shift" in the shoreline created by the filled commercial site also will result in a shift toward the water of the interior coastal zone boundary. The effect of the latter shift will be that 100 acres of residential land will not be included as part of the 1992 coastal zone. In such a case, the "raw' statistics misleadingly suggest that 100 acres of residential land use were eliminated to make room for 100 acres of commercial use.

RESULTS

Oconto County Statistics

Oconto County communities lying within the Lake Michigan. coastal zone include the townships of Little River, Little Suamico, Oconto and Pensaukee and the city of Oconto. The area measured within the coastal zone of Oconto County was 2,787 acres (1,129 ha) in 1978 and 2,839 acres (1,150 ha) in 1992. represents a difference of 52 acres (21 ha) or 1.9%. sections of Oconto County coastal zone lacked 1978 photo coverage. As a result, about 196 acres (79 ha) were not included in the analysis. Additional discrepancies likely are the result of errors inherent in the enlarged aerial photos, as discussed on pages 12 through 15. Using USGS maps as control, tests were conducted on the linear accuracy of the Oconto County photos. Results of tests (2) applied to the 1978 photos indicate significant deviation from USGS measurements. The 1978 photos deviated from the USGS basis by +2.9% and +8.5% while the 1992 photos deviated by -10.8% and -13.1%. The range of deviation is +8.5% to -13.1 and could represent coastal zone area estimates that vary by as much as 600 acres (244 ha) (Table 1).

Statistical summaries for Oconto County and all communities included in this study are located in the Appendix. Summary data sheets present land use types by area, structural counts by type (1992), shoreline modification types by length, and a count of shoreline structures by type. Data were collected at the PLSS section level. While the section level data sheets are not

¹Area figures used in the Results discussion reflect totals (not rounded) reported on the original tally sheets. Figures presented on the tally sheets found in the Appendix of this report have been rounded to the nearest whole number.

Table 1. County Results of Linear Accuracy Tests

Percent Deviation From USGS Base Map Measurements

_County	1978 Enlarged Photos (1:2400)	1992 Enlarged Photos(1:2400)
Brown	-0.4%	-8.5%
	0.03%	- 5.5%
Door	1.3%	-1.1%
	3.9%	-3.6%
Kenosha	-2.5%	-9.0%
	3.1%	-1.6%
Kewaunee	-1.5%	-5.4%
	2.1%	-9.6%
Manitowoc	-1.7%	-6.4%
	2.0%	-7.4%
Marinette (one test)	9.6%	-1.7%
Milwaukee	-4.9%	-6.9%
	-5.3%	1.9%
Oconto	2.9%	-10.8%
	8.5%	-13.1%
Ozaukee	0.2%	- 5.7%
	1.3%	-4.4%
Racine	-3.0%	-5.0%
MacThe	2.2%	-0.8%
Sheboygan	-2.5%	-1.2%
oneboygan	4.6%	-3.0%
	-	
Mean	0.95%	-5.18%
Range	-5.3% to 9.6%	-13.1% to 1.9%

included in this report, copies are available upon written request.

Residential Land

Within the coastal zone of Oconto County, 642 residential structures were identified on 277 acres (112 ha) of land. This total includes 333 residential units (single family or duplexes), 112 detached garages, 165 sheds and 17 barns. Seventeen (17) mobile homes were located on about (5) acres (1.9 ha) of land. Since the 1992 photos are "leaves-on," these numbers likely underestimate the actual number of structures and area devoted to residential uses. In 1978, 291 acres (118 ha) of residential land were measured. The "loss" of 14 acres (5.7 ha) of residential land probably is not real but the result of photo scale and interpretive problems caused by "leaves-on" photos.

Commercial and Industrial Land

Commercial land represented (7) acres (2.8 ha) in 1992, an increase of five (5) acres (2 ha) since 1978. Ten (10) commercial structures of the neighborhood business type were noted within the coastal zone. No industrial land was found within the coastal zone for either year.

Transportation Land

Four (4) structures were located on 11 acres (4.5 ha) of transportation land in 1992. In 1978, 8.4 acres (3.4 ha) of transportation land were reported.

Extractive

In both study years, open pit mining was reported to cover about 4 acres (1.6 ha) of area within the coastal zone.

Agricultural and Natural Land

The photo analysis showed that Oconto gained 93 acres (38 ha) of agricultural and natural lands from 1978 to 1992. The increase, although modest, is counter to trends in other Wisconsin coastal counties. The data show, however, significant losses of active agricultural land and abandoned fields. Abandoned fields declined from 91 acres (37 ha) to 47 acres (19 ha) from 1978 to 1992 while active agricultural land declined from 129 acres (52 ha) to 97 acres (39 ha).

from 129 acres (52 ha) to 97 acres (39 ha).

Also of note is an 86 acre (35 ha) decline of wetland types.

The loss could be actual and attributed to both urban development and the nine (9) inch rise in Lake Michigan water level.

However, a portion of the loss could be attributed to the underestimation of wetlands while using "leaves-on" photos.

Forest area increased dramatically from 91 acres (37 ha) in 1978 to 401 acres (162 ha) in 1992. This increase of 341% likely represents both the abandonment of agricultural uses and the interpretive differences associated with "leaves-off" vs. "leaves-on" aerial photography.

Open and Other Land

During the period studied, Oconto County experienced a 33 acre (13.5 ha) loss within the open/other land use category. The losses included a 5.5 acre (2.2 ha) drop in urban open lot and a 28 acre (11 ha) drop in outdoor recreation area.

Shoreline Modifications

Ostensibly, sea walls and revetments are used to protect shorelines from erosion. In 1978, 3,897 feet (1,188 m) of sea wall were reported compared to 3,068 feet (935 m) in 1992, representing a decrease of 829 feet (253 m). However, far more significant is the 11,921 foot (3,634 m), 44% increase in revetment development since 1978. Shoreline revetment was measured at 26,929 feet (8,210 m) in 1978 and 38,850 feet (11,845 m) in 1992.

Results by Community

Town of Little River

Land within Little River's coastal zone was measured at 758 acres (307 ha) in 1978 and 717 acres (290 ha) in 1992. The difference of 41 acres (16.6 ha) represents 5.4%. However, about 15 acres (6 ha) of land was not represented in 1978 due to missing photo coverage. The source of the difference also could be photo scale anomalies as discussed above.

In 1992, 74 residential structures were located on 98 acres (40 ha) of land. Most of these structures (42) were single family or duplex. In 1978, 105 acres (42 ha) of residential land were reported, (7) acres (2.8 ha) more than reported in 1992. Reasons for such a reduction are discussed above.

No commercial or industrial land was identified on either the 1978 or 1992 photos. In the transportation category, about (2) acres (.8 ha) of the type public boat landing were developed by 1992. No area devoted to such use was recorded for 1978.

Agricultural and natural areas decreased from 606 acres (245 ha) in 1978 to 585 acres (237 ha) in 1992. Active agricultural land increased by 6.4 acres (1.8 ha), while forest land increased by 87 acres (35 ha).

Wetlands lost the most area (102 acres, 41 ha) of any type within the natural lands category. Wetlands declined from 577 acres (234 ha) in 1978 to 475 acres (192 ha) in 1992.

Open/other land types decreased by 15 acres (6 ha) during the period studied. Urban open lot areas decreased from 2.9

acres (1.2 ha) in 1978 to .5 acres (.2 ha) in 1992, suggesting the process of infilling is occurring along near-shore lots. The outdoor recreation type decreased as well, from 45 acres (18 ha) in 1978 to 32 acres (13 ha) in 1992.

From 1978-1992, some shoreline modification has occurred within the town. Sea wall construction increased by 335 feet (102 m) or 89%, from 376 feet (115 m) to 711 feet (217 m). Revetment fell a bit from 11,012 feet (3,357 m) to 10,746 feet (3,276 m), a decrease of 266 feet (81 m). One (1) groin was located in each of the study years.

Town of Little Suamico

Coastal zone area within the township was measured at 556 acres (225 ha) in 1978 and 630 acres (255 ha) in 1992, a difference of 74 acres (30 ha). Photo coverage for 1978 was missing for a portion of Little Suamico. When the missing area is added, the 1978 area total becomes 640 acres (260 ha) and the 1978/1992 area discrepancy drops to just 11 acres (4.5 ha).

In 1992, a total of 129 residential structures were identified on 30 acres (12 ha) of residential land. Of these, 66 were of the single family/duplex type.

In 1992, two (2) commercial structures were located on 1.5 acres (.6 ha) of commercial land. The total area represents a modest increase over 1978. No industrial land was identified for either study year.

Transportation land within the coastal zone increased by (4) acres (1.6 ha) from 1978 to 1992. Almost all of the increase was due to development of public boat landing facilities.

Agricultural and natural areas increased from 509 acres (206 ha) to 594 acres (241 ha) for the period studied. The increase, although modest, is counter to land use trends experienced elsewhere. While active agricultural land decreased slightly, abandoned fields decreased by 16.7 acres (6.8 ha) or by 82%. Open water declined in area, as well, falling from 30 acres (12 ha) in 1978 to 8 acres (3.2 ha) in 1992. Two natural types, forest and wetland, increased in area. Forest land increased from 5.4 acres (2.2 ha) to 102 acres (41 ha) while wetlands increased from 445 acres (180 ha) to 473 acres (192 ha).

Results indicate a loss of 862 feet (263 m) of sea wall and a 1,088 foot (332 m) increase in revetment. The loss of sea wall may represent masking by leaves and shadows rather than actual losses of the shoreline structures. By 1992, two (2) groins had been built in the township.

City of Oconto

In 1978, a total of 221 acres (90 ha) comprised the coastal zone of Oconto. In 1992, 285 acres (115 ha) were located within the coastal zone. However, for the year 1978, 96 acres (39 ha) of photo coverage of the coastal zone was missing.

Residential land encompassed only 16 acres (6.4 ha) in 1992, which represents a modest increase over the 1978 residential area of 5.4 acres (2.2 ha). Fifty-six (56) structures, of which 29 were single family/duplex, were located within the 1992 coastal zone.

No commercial or industrial land was identified within the coastal zone during the period studied. A (5) acre (2 ha) increase of the transportation type public boat landing was documented, however.

For both study years, over 90% of the coastal zone fell into agricultural and natural land use types. A total of 208 acres (84 ha) were reported within these categories for 1978, while 263 acres (107 ha) were reported for 1992. Within these types, open water decreased by 19 acres (7.7 ha) while wetlands increased by 73 acres (30 ha). Both of these findings are contrary to current state trends.

Analysis of shoreline modifications appears problematic. While sea walls increased by 102 feet (31 m), which would be expected over a 14 year period, revetments declined by 2,509 feet (765 m) over the same period.

Town of Oconto

The coastal zone for the town of Oconto was determined to be 284 acres (113 ha) in 1978 and 257 acres (104 ha) in 1992. The 27 acre (11 ha) difference is 9.5% of the 1978 total. The town of Oconto was one of the sites tested to determine linear accuracy of the enlarged photos. The 1978 photos of Oconto were determined to deviate +2.9 from USGS 1:24000 maps. However, the 1992 photo measurements deviated from the USGS maps by -10.8%.

The amount of residential land located within the coastal zone remained stable from 1978 to 1992 at about 45 acres (18 ha). Within the residential area were counted 89 structures, 48 of which were identified to be single family/duplex.

Commercial land accounted for less than an acre of the coastal zone in 1992. No commercial land was evident in 1978. No industrial land was identified for either year.

For both years, no significant areas of transportation or extractive land uses were found within the coastal zone.

Agricultural and natural lands represented the highest percentage of coastal zone area for both 1978 and 1992, 76% and 79%, respectively. In 1978, 215 acres (87 ha) were identified in these categories, while in 1992, 204 acres (85 ha) were identified. Within these categories, active agricultural land declined by 18 acres (7.3 ha), from 42 acres (17 ha) to 24 acres (9.9 ha) while forest lands increased by 15 acres (6 ha), from 15 acres (6 ha) to 30 acres (12 ha). The types open-water and wetland remained stable over the study period.

The open-other land use category declined in area by (8) acres (3.2 ha) from a 1978 total of 18 acres (7 ha) to the 1992 total of 9.7 acres (3.9 ha). The largest loss within the

category was found in the outdoor recreation type, slipping from 17 acres (7 ha) to 9.7 acres (3.9 ha).

Modifications to the coastal shoreline increased markedly for revetment structures. In 1978 there were 1,587 feet (484 m) of revetment. This total increased to 3,723 feet (1,135 m) by 1992, an increase of 135%. No sea walls were located in 1978 compared to 59 feet (18 m) in 1992.

Town of Pensaukee

As measured, the coastal zone of Pensaukee consisted of 968 acres (392 ha) in 1978 and 950 acres (385 ha) in 1992. The 18 acre (7.3 ha) difference is 1.8% of the 1978 total. The town of Pensaukee was one of the sites tested to determine linear accuracy of the enlarged photos used for this study. The 1978 photos of Pensaukee deviated from the USGS basis by +8.5%. The 1992 photos tested deviated from the USGS basis by -13.1%.

Residential land was estimated to be about 90 acres (36 ha) for both 1978 and 1992. Within this area were located 148 single family/duplex units, 56 detached garages, 82 sheds, (5) barns and (3) mobile homes.

Commercial land of the type neighborhood business increased by 3.6 acres (1.5 ha) to 4.6 acres (1.9 ha) by 1992. No industrial land was located within the coastal zone for either study year.

Just over (6) acres (2.6 ha) of transportation land were identified in 1978, about (5) acres (2.1 ha) of which were categorized as treatment plant. No transportation land use was tallied in 1992. During each study year, about (4) acres (1.7 ha) of open pit mining were located within the town's coastal zone.

For both 1978 and 1992, the vast majority of land use within the coastal zone of Pensaukee fell within the agricultural/natural category. In 1978, 860 acres (349 ha) of land were assigned this category while in 1992, 846 acres (342 ha) were so assigned. While total area remained stable over the period, some significant changes did occur. Both abandoned field and active agricultural land uses declined, abandoned field by 30 acres (12 ha) or 42%, and active agricultural land by 20 acres (8.2 ha) or 25.6%. Losses in area also were reported for the open-water and wetland types, 9.7 acres (3.9 ha) or 49.7%, and 78 acres (32 ha) or 12.3%, respectively. Forest land, however, experienced a significant increase, from the 1978 total of 59 acres (24 ha) to 182 acres (74 ha) in 1992.

In the open-other use category, urban open lots remained stable over the period at about 5.5 acres (2.2 ha).

Shoreline modification of the types sea wall and revetment show both a decline and an increase over the study period. Sea walls represented 2,445 feet (745 m) in 1978 but dropped to 1,982 feet (604 m) by 1992. The decline represents 463 feet (141 m) or 18.9%. Revetments, however, represented 8,104 feet (2,471 m) in

1978 and 14,792 feet (4,510 m) in 1992, an increase of 6,688 feet (2,039 m) or 83%.

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APPENDIX

Lake Michigan Coastal Development Inventory Project: 1978 - 1992

County Summary Data Sheet

Year: 1978 County: Oconto Coastal Civil Jurisdicti order).	mary (in alphabetica)
Town of Little River Town of Little Suamic City of Oconto Town of Oconto Town of Pensaukee	

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ente com no mantes e agagitar e senas.	ووفيره بالهالة ويستوعه	# of structu	res	Ar Acres	
11 Residential					
111 Res. units	·	·.			
garages					
sheds					•
112 Res. units					
sheds					
113 Res. units		368		287	116
garages		111			
sheds		244			
barns	<u> </u>	3			
115 Res. units garages		26		5	<u>Z</u>
sheds			· · · · · · · · · · · · · · · · · · ·		
	Subtotal			291	118
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_12 Commercial				•	•
121 Control Bug	_		1. 1.		
121 Central Bus 122 Shopping Ce	iness bist _ nter/Mall				
124 Neighborhoo	d Business D	ist 5		2	1
126 Institution	al				
	Subtotal	5	-	2	1
13 Industrial	estronomical de la companya de la c	Marine a succession was to a succession of		•	

Area

Acres Hectares # of structures 14 Transportation 141 Air Transportation __ 142 Rail Transportation _____ 143 Water Transportation ____ 26 143.1 Private Marina _____ 143.2 Public Boat Landing ____ 144 Highways 145 Communications ____ 146 Utilities 147 Sewage Treatment Plant ___ 148 Landfill Subtotal 31 17 Extractive 171 Open Pit 172 Underground _____ 173 Well 179 Other Extractive Subtotal _ RPE.LL 18 Agricultural and Natural ___181 AF Abandoned Field __ 182 AG Agriculture Active ____ 129 183 F Forest _____ 91 ___185 OW Open Water _____ 186 RL Rock Ledge 187 SL Slump Zone _____ 188 WT Wetland 1965 796 Subtotal 2399 971 19 Open Land, Other 191 Outdoor-Public Assembly _ 192 Urban Open Lots _____ 12 193 Outdoor Recreation ____ 26 70 28 194 Cemeteries Subtotal 82 The second secon Total Acres 2787 Total Hectares 1129

Shoreline Modifications	Linear		
	<u>Feet</u>	<u>Meters</u>	
195 Sea Walls	3897	1188	
196 Revetments	26929	8210	
197 Groins	# of Groins 2		
198 Dock Non-Flow-Through	# of Docks		

Lake Michigan Coastal Development Inventory Project: 1978 - 1992

County Summary Data Sheet

Year: 1992 County: Oconto

Coastal Civil Jurisdiction included in summary (in alphabetical

order).

Town of Little River
Town of Little Suamico

City of Oconto Town of Oconto Town of Pensaukee

LAND USE CATEGORIES

				Area	
		j	of structures	Acres	<u> Hectares</u>
<u>11 Res</u>	<u>sidential</u>	•			
	_ •.				
111	Res. units	·			
	garages sheds				
112	Res. units				
112	garages				
	sheds				
113	Res. units		333	272	110
	garages		112		
	sheds		165		
	barns		15		
115	Res. units		17	5	22
	garages				
	sheds				
		Subtotal	642	277	112
40.0					
12 Col	mmercial				
121	Central Bue	iness Dist			
	Shopping Ce				
		d Business D:	ist 10	7	3
	Institution				
		Subtotal	10	7	3
13 Inc	dustrial				
138	Industrial :	Park			,

14 Transportation 141 Air Transportation __ 143.1 Private Marina _____ 143.2 Public Boat Landing _____4 11 144 Highways 145 Communications _____ 146 Utilities 147 Sewage Treatment Plant _ 148 Landfill Subtotal 11 17 Extractive 172 Underground _____ 173 Well 179 Other Extractive _ Subtotal 18 Agricultural and Natural 39 183 F Forest _____ 401 162 184 H Heath 185 OW Open Water _______66 186 RL Rock Ledge _____ 187 SL Slump Zone _ 188 WT Wetland 1879 761 Subtotal 2492 1009 19 Open Land, Other 191 Outdoor-Public Assembly ____ 192 Urban Open Lots 193 Outdoor Recreation ____ 194 Cemeteries Subtotal 48 Total Acres 2839 Total Hectares 1150 Shoreline Modifications Linear Feet Meters 935 195 Sea Walls 3068 38850 196 Revetments 11845 197 Groins # of Groins 3 198 Dock Non-Flow-Through # of Docks

Civil Jurisdiction Summary Data Sheet

Year: 1978 County: Oconto Township, Village PLSS section data description):	or City na sheets <u>inc</u>	ame: Town of Li cluded in summar	ttle River Y (give full	
SE	C 4 C 5 C 8 C 9	T29N R22E SEC SEC SEC SEC SEC SEC SEC	24 26 27 28 33	
*****	TAMP	HOR CAMECODIEC		
	LAND	USE CATEGORIES		
	•	•		ea
•		# of structure	s <u>Acres</u>	<u>Hectares</u>
11 Residential			•	. * · · · · · · · · · · · · · · · · · ·
The state of the s		e	•	
111 Res. units garages	-		· · · · · · · · · · · · · · · · · · ·	
sheds				
112 Res. units				
sheds				
113 Res. units		104	105	42
garages sheds		<u>35</u> 60		
barns		1		
115 Res. units				
garages sheds				
	Subtotal	200	105	42
12 Commonatal				•
12 Commercial				
121 Central Bus 122 Shopping Ce 124 Neighborhoo 126 Institution	nter/Mall d Business al	Dist		
	Subtota	1		
13 Industrial	• • • • • • • • • • • • • • • • • • • •			
138 Industrial	Park		**	

Area

of structures Acres Hectares 14 Transportation 143.1 Private Marina _ 143.2 Public Boat Landing _____ 144 Highways 145 Communications 146 Utilities 147 Sewage Treatment Plant ______ 148 Landfill Subtotal 17 Extractive 171 Open Pit 172 Underground _____ 173 Well 179 Other Extractive Subtotal 18 Agricultural and Natural 181 AF Abandoned Field _ 182 AG Agriculture Active _____ 183 F Forest 184 H Heath <1 185 OW Open Water _ 185 OW Open Water 186 RL Rock Ledge 187 SL Slump Zone _____ ___188 WT Wetland 577 234 Subtotal 606 245 19 Open Land, Other 191 Outdoor-Public Assembly _____ 192 Urban Open Lots _____ 193 Outdoor Recreation 10 45 194 Cemeteries Subtotal 10 Total Acres 758 Total Hectares

Shoreline Modifications	Line	Linear		
	. Feet	<u> Meters</u>		
195 Sea Walls	376	115		
196 Revetments	11012	3357_		
197 Groins	# of Groins	1		
198 Dock Non-Flow-Through	# of Docks			

Civil Jurisdiction Summary Data Sheet

Year: 1992

County: Oconto
Township, Village or City name: Town of Little River
PLSS section data sheets <u>included in summary</u> (give full

description):

T28N	R22E	SEC	4	T29N	R22E	SEC	23
		SEC	5			SEC	24
		SEC	8			SEC	26
		SEC	9			SEC	27
						SEC	28
						SEC	33
						SEC	34

			Area	
		# of structures	Acres	<u> Hectares</u>
11 Residential				
111 Res. units garages sheds				
112 Res. units garages sheds				
113 Res. units			98	40
garages sheds		13		
barns		<u>13</u>		
115 Res. units				
garages				
sheds	Guillata a ta a D	7.4		
	Subtotal	. 74	. 98	40
12 Commercial				
121 Central Bus	iness Dist			
122 Shopping Ce	nter/Mall _			
		Dist		
126 Institution				
	Subtota	L		
13 Industrial				
138 Industrial	Park			

Civil Jurisdiction Summary Data Sheet

Year: 1978

County: Oconto Township, Village PLSS section data description):	or City name sheets <u>incl</u>	e: Town of Littl uded in summary (e Suamico give full	
SE SE SE SE SE	C 9 C 17 C 19 C 20 C 29 C 30 C 31 C 32	SE CATEGORIES		
			Are	
	į	f of structures	Acres	<u> Hectares</u>
11 Residential	s posterior de l'anno de		• •	· -
111 Res. units garages sheds 112 Res. units garages			•	
sheds	· ·			
113 Res. units garages sheds		74 22 35	41	16
barns				
115 Res. units garages sheds		13	2	1
Sileus	Subtotal	. 144	43	17
12 Commercial				
121 Central Bus	iness Dist _			
122 Shopping Ce	nter/Mall			
124 Neighborhoo 126 Institution	d Business D	ist	1	1
126 Institution	Subtotal	5	1	1
13 Industrial	en amerikan kanan di		•	

138 Industrial Park _____

Area

		# of structure	Area es <u>Acres</u> F	<u>lectares</u>
14 Tr	ansportation			
141	Air Transportation			
142	Rail Transportation	······································		
143	.1 Private Marina			
143	.2 Public Boat Landing		<1	<1
144	Highways			
145	Highways Communications			
	1 = 1 . 1			
147	Sewage Treatment Plant		· · · · · · · · · · · · · · · · · · ·	
148	Landfill			
-	Subtotal		<1	<1
17 Ext	tractive			
171	Open Pit			
172	Open Pit Underground			
173	Well			
179	Other Extractive			
	Subto	otal		
18 Aq1	cicultural and Natural			•
101	No shoulened bield		20	
191	AF Abandoned Field		20	<u>8</u> 3
102	AG Agriculture Active		9 5	2
194	F Forest H Heath			<1
	OW Open Water		30	12
186	RL Rock Ledge			
187	SL Slump Zone			
188	WT Wetland		445	180
	Subtotal		500	206
9		<i>f</i>	m, .	
19 Ope	en Land, Other	90 F - 100 - 0		
		w ·		
191	Outdoor-Public Assembl	ly		
192	Urban Open Lots		3	1
193	Outdoor Recreation			
194	Cemeteries			
	Subtotal	•	3	1
			Total Acres	556
		4	Total Hectares	225
				200
Shore	line Modifications		Linea	
			<u>Feet</u>	<u> Meters</u>
			1076	328
-	Revetments		5855	<u> 1785</u>
	Groins	·····	# of Groins	
198	Dock Non-Flow-Through		# of Docks	

Civil Jurisdiction Summary Data Sheet

Year: 1992

County: Oconto
Township, Village or City name: Town of Little Suamico
PLSS section data sheets included in summary (give full

description):

T26N R21E SEC 8 SEC 9 **SEC 17 SEC 19** SEC 20 SEC 29 SEC 30 SEC 31

		# of structures	Are <u>Acres</u>	ea <u>Hectares</u>
11 Residential				
111 Res. units garages sheds				
112 Res. units garages sheds				
113 Res. units		66	26	11
garages		21		
sheds		28		
barns				
115 Res. units garages sheds		14	4	2
	Subtotal	129	30	12
12 Commercial			,	
121 Central Bus	_			
122 Shopping Ce				
124 Neighborhoo 126 Institution		Dist	22	1
126 Histitution	Subtotal	2	2	1
13 Industrial				
138 Industrial	Park			<i>3</i>

	" - 6 -		Are	
	# OI S	tructures	<u>Acres</u>	<u> Hectare</u>
14 Transportation				
141 Air Transportati	on			
142 Rail Transportat 143 Water Transporta 143.1 Frivate Marina 143.2 Public Boat La	ion			
143 Water Transporta	tion		<1	<1
143 1 Drivate Marina		A.		
143.1 Filvace Mailing	nding	9!		
145.2 Public Boat La	naing			
144 Highways 145 Communications _				
146 Utilities 147 Sewage Treatment				
14/ Sewage Treatment				
148 Landfill				
Subt	otal	4	4	2
17 Extractive				
171 Open Pit				
171 Open Pit 172 Underground				
173 Well				
179 Other Extractive				
	Subtotal			
18 Agricultural and Na	tural			
			_	_
181 AF Abandoned Fie	та.———		4	2
182 AG Agriculture A				3
				41
184 H Heath 185 OW Open Water _		- <u>-</u>		
185 OW Open Water			88	3
186 RL Rock Ledge				
187 SL Slump Zone				
188 WT Wetland			473	192
Subt	otal		594	241
19 Open Land, Other				
191 Outdoor-Public A	ssembly			
192 Urban Open Lots		1	<1	<1
193 Outdoor Recreati	on			
194 Cemeteries				
	otal	1	<1	<1
		ग	otal Acres	630
			Cotal Hectare	
Shoreline Modification	_		Tiw	near
Shoreline Modification	<u>5</u>		Feet	Meter:
195 Sea Walls			214	65
106 Barrahmanha			6943	2117
			# of Groins	
197 620180				
197 Groins 198 Dock Non-Flow-Th			# OF BEELE	<u> </u>

Civil Jurisdiction Summary Data Sheet

Year: 1978 County: Oconto

Township, Village or City name: City of Oconto PLSS section data sheets included in summary (give full

description):

T28N R22E SEC 16 SEC 17 SEC 20 SEC 21

- 138 Industrial Park _____

LAND USE CATEGORIES Area # of structures Acres Hectares 11 Residential an an ann ann an an an an a terral was written and a second of the sec ----111 Res. units garages sheds 112 Res. units garages -10 - 113 Res. units ·- garages 9 sheds barns 115 Res. units garages sheds Subtotal 19 12 Commercial 124 Neighborhood Business Dist ____ 126 Institutional Subtotal ırk - 13 Industrial

<u>Hectares</u>

of structures

			# of	structur		Hectares
44 500				<u> </u>		
14 Tr	ansportation					
141	Air Transporta	ation				
142	Rail Transport	tation				
143	Water Transpor	rtation				
143	1 Private Mari	ina				
143	.1 Private Mar: .2 Public Boat	Landing		***************************************	~1	<u> </u>
143	Highways	Danazng				
1/5	Highways Communications					
147	Sewage Treatme	nt Plant				
147						
140		ubtotal		······································	<1	<1
	30	IDCOCAT			\1	71
17 Ex	<u>cractive</u>			•		
171	Open Pit					
172	Underground _					
173	Well _					
179	Other Extracti	ive	 			
		Subto	tal			
			3			
18 Agr	cicultural and	<u>Natural</u>	/			
					• ,	2.1
181	AF Abandoned B	Field				
182	AG Agriculture	e Active .				
183	F Forest _				<1	<1
184	H Heath					
185	OW Open Water RL Rock Ledge				45	18
186	RL Rock Ledge					
187	SL Slump Zone					
188	WT Wetland				163	66
• •		btotal			208	84
19 Ope	en Land, Other		•	••		
•				•		
191	Outdoor-Public	: Assembl	У	•		
192	Urban Open Lot	s			•	
193	Outdoor Recrea	tion		7	7	3
194	Cemeteries	_				
	Sy	ubtotal		7	7	3
					Total Acres	22.1
					Total Hectar	es 90
Shoro	line Modificati	ons			T i	near
Shore	TIME MOUITICATI	CIIS			Feet	near <u>· Meters</u>
105	Sea Walls _				Leer	<u>, neceir 9</u>
					074	444
	Revetments				371	113
	Groins	Mile on many 12 h			# of Groin	
198	Dock Non-Flow-	-unrougn			# of Docks	

Civil Jurisdiction Summary Data Sheet

Year: 1992

County: Oconto
Township, Village or City name: City of Oconto
PLSS section data sheets <u>included in summary</u> (give full

description):

T28N R22E SEC 16 **SEC 17**

SEC 20

SEC 21

			Area		
		<pre># of structures</pre>	Acres	<u> Hectare</u>	
1 Residential		•			
111 Res. units					
garages sheds					
112 Res. units					
garages					
sheds 113 Res. units		29	16	7	
garages	•	8	10		
sheds		19			
barns					
115 Res. units garages			,		
sheds					
	Subtotal	56	16	7	
2 Commercial					
121 Central Ruc	iness Dist				
122 Shopping Ce					
124 Neighborhoo	d Business	Dist			
126 Institution					
	Subtotal				
3 Industrial					

102 2646

807_

14 Transportation

144 Highways

146 Utilities

148 Landfill

17 Extractive

173 Well

184 H Heath

188 WT Wetland

19 Open Land, Other

194 Cemeteries

195 Sea Walls

196 Revetments

197 Groins# of Groins198 Dock Non-Flow-Through# of Docks

Civil Jurisdiction Summary Data Sheet

Year: 1978

County: Oconto
Township, Village or City name: Town of Oconto
PLSS section data sheets <u>included in summary</u> (give full

description):

T28N R22E SEC 28 SEC 29

SEC 31

SEC 32

LAND USE CATEGORIES

Area # of structures Acres Hectares 11 Residential And the second of the second o 111 Res. units garages sheds - 112 Res. units - garages sheds 48 - 113 Res. units _ 50 garages 13 sheds 24 barns 115 Res. units garages sheds Subtotal 86 50 12 Commercial 121 Central Business Dist _ 122 Shopping Center/Mall _____ 124 Neighborhood Business Dist _ 126 Institutional _ Subtotal • المراجع المستعملات المستعملات 13 Industrial Market Committee the second of the second of 138 Industrial Park _____

Area # of structures Acres Hectares 143.2 Public Boat Landing 145 Communications _____ 147 Sewage Treatment Plant ____ Subtotal 9 171 Open Pit
172 Underground Subtotal 18 Agricultural and Natural 181 AF Abandoned Field _____ 182 AG Agriculture Active 42 183 F Forest
184 H Heath 15 185 OW Open Water _____ 186 RL Rock Ledge 187 SL Slump Zone 148 60 Subtotal 215 87 191 Outdoor-Public Assembly _____ 192 Urban Open Lots ______ 1 <1 193 Outdoor Recreation _____ 9 17 Subtotal Total Acres 284 Total Hectares 113 Shoreline Modifications Linear Feet Meters

1587

of Groins

198 Dock Non-Flow-Through _____ # of Docks

484

14 Transportation

144 Highways

146 Utilities

148 Landfill

17 Extractive

173 Well

188 WT Wetland

19 Open Land, Other

194 Cemeteries

195 Sea Walls 196 Revetments

197 Groins

179 Other Extractive

Civil Jurisdiction Summary Data Sheet

Year: 1992

County: Oconto
Township, Village or City name: Town of Oconto
PLSS section data sheets <u>included in summary</u> (give full

description):

T28N R22E SEC 28 SEC 29

SEC 31 SEC 32

	•		Area	
		# of structures	Acres	<u> Hectares</u>
11 Residential				
111 Res. units garages sheds				
112 Res. units garages sheds				
113 Res. units		48	42	17
garages	•	14		
sheds barns		23		
115 Rés. units		4		
garages sheds				
	Subtotal	89	42	17
12 Commercial 121 Central Bus	iness Dist _			
122 Shopping Ce	nter/Mall		···	
		ist <u>6</u>	1	<1
126 Institution	al Subtotal	6	1	<1
13 Industrial				
138 Industrial	Park			····

Area

	<pre># of structures</pre>	Acres H	<u>ectares</u>
14 Transportation			
141 Bin Mary my sytation			
141 Air Transportation		· · · · · · · · · · · · · · · · · · ·	
142 Rail Transportation			
143 Water Transportation			
143.1 Private Marina			
143.2 Public Boat Landing			
144 Highways 145 Communications		· · · · · · · · · · · · · · · · · · ·	
146 Utilities			
146 Utilities 147 Sewage Treatment Plant			
147 Sewage Treatment Plant			
148 Landfill		· · · · · · · · · · · · · · · · · · ·	
Subtotal			
17 Extractive			
171 Open Pit			
171 Open Pit 172 Underground			
172 14_11			
179 Other Extractive			
Subto	otal		
18 Agricultural and Natural			
10 Agricultural and Nacular			
181 AF Abandoned Field		1	<1
182 AG Agriculture Active		24	10
		30	12
184 H Heath		1	<1
185 OW Open Water		8	3
186 RL Rock Ledge			
187 SL Slump Zone			
100 tim Mahland		141	57
Subtotal		204	83
19 Open Land, Other			
191 Outdoor-Public Assembl	LY	 	
193 Outdoor Recreation		10	4
194 Cemeteries Subtotal		10	
Subtotal		10	4
	Tot	al Acres	257
		al Hectares	104
		_	
Shoreline Modifications		Linea	
		<u>Feet</u>	<u>Meters</u>
195 Sea Walls		59	<u> 13</u>
		3723	1135
197 Groins			
198 Dock Non-Flow-Through	#	of Docks	

Civil Jurisdiction Summary Data Sheet

Year: 1978

County: Oconto Township, Village PLSS section data description):	or City namesheets <u>incl</u>	ne: Town of Pens Luded in summary	saukee (give full	
T26N R21E SE SE	C 3	SEC 27 SEC 34		
T27N R21E SE SE	C 1 C 11	T27N R22E SEC 5		
SE SE SE	C 12 C 13 C 14 C 23	SEC 6		
SE	C 26	ICE CAMECODIES		
A STATE OF THE STA	LAND (JSE CATEGORIES		
		7.	Ar	ea.
		<pre># of structures</pre>	Acres	Hectares
11 Residential				**
111 Res. units				
garages	•			
sheds				
112 Res. units				
garages				
sheds 113 Res. units		132	87	35
		41	8 /	35
garages sheds		116	· · · · · · · · · · · · · · · · · · ·	
barns		1		
115 Res. units	-	1:3	3	1
garages sheds				
	Subtotal	303	89	36
12 Commercial				
121 Central Bus 122 Shopping Ce				
124 Neighborhoo	d Rusinece T)ist	1	<1
126 Institution				
	Subtotal		1	<1
13 Industrial				
138 Industrial	Park			

Civil Jurisdiction Summary Data Sheet

Year: 1992 County: Oconto

County: Oconto Township, Village PLSS section data description):						
T26N R21E S	EC 3	SEC 27				
SI		SEC 34				
T27N R21E S						
		T27N R22E SEC 5				
	SEC 12 SEC 6					
	EC 13					
	EC 14 EC 23					
	EC 26					
.		E CATEGORIES				
			λν	0.3		
	<u>#</u>	of structures	Ar <u>Acres</u>	Hectares		
11 Residential						
111 Res. units						
garages						
sheds 112 Res. units	 					
						
garages sheds						
113 Res. units		148	90	36		
garages		F.6				
sheds		82				
barns		5				
115 Res. units		3	11	<1		
garages						
sheds	Subtotal	294	91	37		
	Subcocal	294	91	37		
12 Commercial						
121 Central Bus	siness Dist					
122 Shopping Co	enter/Mall					
124 Neighborho	od Business Di	st <u>2</u>	5	22		
126 Institution						
	Subtotal	2	5	2		
13 Industrial						
138 Industrial	Park					

Area # of structures Acres Hectares

	# of	structure	es <u>Acres</u>	<u>Hectares</u>
14 Transportation				
141 Air Transportation 142 Rail Transportation 143 Water Transportation 143.1 Private Marina 143.2 Public Boat Landing 144 Highways 145 Communications 146 Utilities 147 Sewage Treatment Plant 148 Landfill				
Subtotal				
17 Extractive				
4 T D				
Subto	tal	1	4	2
18 Agricultural and Natural	-			
185 OW Open Water 186 RL Rock Ledge 187 SL Slump Zone			58 182 1 1	74 <1 4
188 WT Wetland			554 846	225 342
19 Open Land, Other 191 Outdoor-Public Assembl	v			3.2
192 Urban Open Lots			5	2
193 Outdoor Recreation		···		
Subtotal			5	2
			Total Acres Total Hectares	950 385
Shoreline Modifications			Line	
195 Sea Walls			1982	<u>Meters</u> 604
196 Revetments				
197 Groins 198 Dock Non-Flow-Through			<pre># of Groins # of Docks</pre>	